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AUTHOR	Dori, D.; And Others
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ABSTRACT

Since real-life situations of trauma training are practically not available, a proper substitute must take advantage of the most recent advents in multimedia and groupware technologies. Multimedia visualization is of particular importance in trauma training, as the most crucial step of the patient's initial assessment is largely based on a surface check. Using trauma team training as a case in point, the long-term goal of a project by a group of Industrial Engineering and Management at Technion faculty, Israel Institute of Technology, is to design a domain-independent team training shell (TTS)--a generic scheme for team training application generator. It is expected to enable the creation of training executables in any domain that involves the need for coordination among team members charged with a common mission. The design of the TTS architecture requires the integration of concepts and techniques from multimedia-supported human-machine interaction environment, groupware-based team collaboration, networking and distributed applications and databases. Work is oriented towards obtaining synergy through integrating the benefits of groupware with multimedia. This paper describes the background and considerations involved in the TTS design by using the trauma team training as a case in point. A trauma scenario example with representative computer screens are offered as illustration. (Author)

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Team Training Shell: a Groupware, Multimedia-Supported Application Generator

D. DORI, M. ALON, AND Y.J. DORI

Faculty of Industrial Engineering and Management
Technion, Israel Institute of Technology, Haifa 32000, Israel

Abstract

Since real-life situations of trauma training are practically not available, a proper substitute must take advantage of the most recent advents in multimedia and groupware technologies. Multimedia visualization is of particular importance in trauma training, as the crucial step of the patient's initial assessment is largely based on surface check. Using trauma team training as a case in point, our long-term goal is to design a domain-independent Team Training Shell (TTS)—a generic scheme for team training application generator. It is expected to enable the creation of training executables in any domain that involves the need for coordination among team members charged with a common mission. The design of the TTS architecture requires the integration of concepts and techniques from multimedia-supported human-machine interaction environment, groupware-based team collaboration, networking and distributed applications and databases. Our work is oriented towards obtaining synergy through integrating the benefits of groupware with multimedia. In this paper, we describe the background and considerations involved in the TTS design by using the trauma team training as a case in point.

Multimedia as a Supporting Technique

Most existing software systems support the interaction between the user and the system, but usually do not support interaction among users. We focus on the class of coordination systems, that allow individuals to view their actions, as well as the relevant actions of others, within the context of the overall goal. The main conceptual components of a coordinated groupware system are the following [3]: **Shared context**: A set of objects and actions performed on these objects that are visible to a set of users. **View**: A multimedia representation of some portion of a shared context. **Role**: A set of privileges and responsibilities attributed to an agent. **Coordination management**: A mechanism for coordinating simultaneous operations.

It is within the View component of that multimedia is heavily involved. The contribution of multimedia is especially important in the case of training systems, as these systems require human cooperative responses to simulated real-life situations displayed to them. Multimedia combines elements of motion and still video images, special effects, synthetic video, fast graphics and text with the interactive capabilities of a desktop workstation. Although most of the research in this area centers on individual multimedia applications that use stand-alone workstations, great potential for multimedia lies in the wide-spread development and use of distributed multimedia applications [1]. There is a number of existing experimental multimedia-based systems. Among them are EDUCOM [5], and IRIS Intermedia system [4]. Our work is oriented towards obtaining synergy through integrating the benefits of groupware with multimedia, while alleviating the burden of taking care of the complex management, control and coordination problems discussed above. The tool that we propose for this purpose

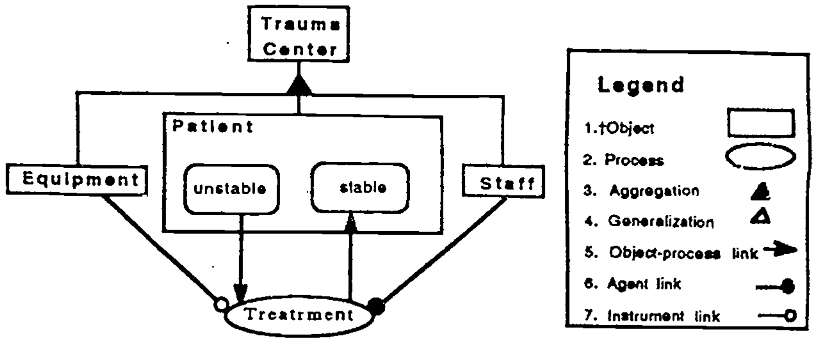

Figure 1: An OPD of a Trauma Center

is the Team Training Shell (TTS). Before going into the details of the shell, we introduce the Object-Process Analysis (OPA) methodology that we use as a tool for designing the TTS.

Object process Analysis

The basic observation underlying the Object Process Analysis (OPA) [2] approach is that every thing in the universe of interest can be classified either as an object or as a process. The approach combines Object Oriented Analysis (OOA) to represent the static-structural aspects, and the Data Flow Diagram (DFD) to represent the dynamic-procedural aspects, into one integrated representation approach, Object-Process Diagram (OPD). Figure 1 is an OPD of a trauma center. A trauma center consists of three main objects: Staff, Equipment and Patient, depicted as rectangular boxes, and a Treatment process, shown as an ellipse. The object treated by the process is an unstable patient and the desired outcome is a stabilized patient.

As shown in the legend of Figure 1, an Object-Process link leads from objects to processes and vice versa, describing the input and output objects needed to maintain the process. Blank and solid disks terminating a line, denote instrument and agent links, respectively. An instrument link connects the object which is needed to carry out the process at which it points. Likewise, the agent link connects the object (usually person), which carries out the process at which it points. Solid and blank triangles denote the two basic structural relations whole-part and generalization-specialization, respectively.

The Team Training Shell (TTS)

The Team Training Shell (TTS) is a multimedia-supported framework for developing training modules for teams who work in coordination to achieve a common goal. The system in figure 2 consists of three main processes: Training Authoring, Training Execution and Evaluation. The main purpose of TTS is to transfer the Team from a base-level proficiency to an improved one.

The Team Training Authoring process is carried out by the Team Training Author, who has the Domain Knowledge and uses TTS with its Supporting Environment as the authoring instrument. In this authoring process, the domain expert generates an Executable Training Module which has a Training Scenario Tree. A node in this tree represents a decision point while each edge represents the relative weight assigned to the selected action.

The resulting Executable Training Module is used as input to the Team Training Execution process. This process is supervised by the Team Trainer, who is a domain expert that has Domain Knowledge. The Supporting Environment is an integrated server combining a Multimedia interface, a Communication unit, an extended Database management system and a

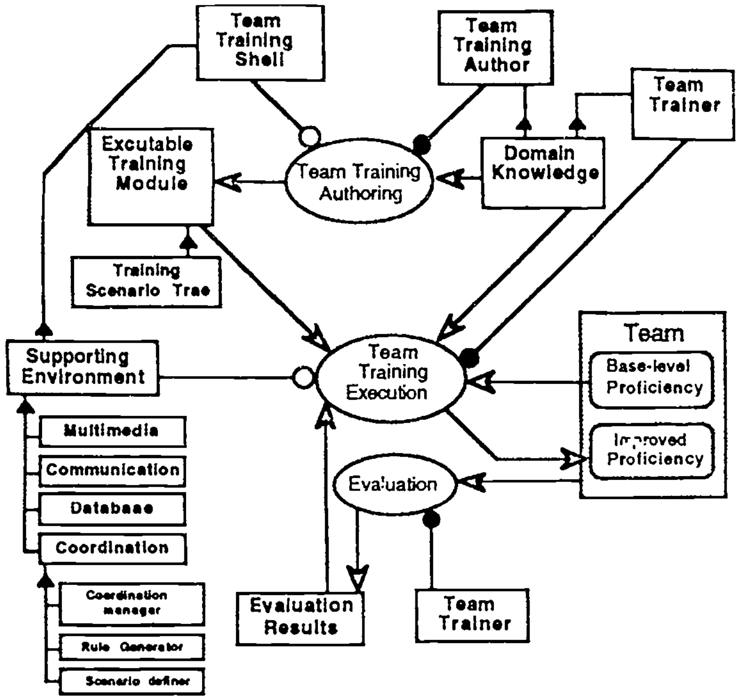

Figure 2: Team Training Shell - conceptual overview

Coordination management unit. It provides both the Authoring and the Execution processes with the appropriate tools. Among them is the multimedia tool kit, which allows selection of the suitable media combination, the activation time and duration. The Evaluation process provides ongoing follow-up facilities. Its important constituents are performance history logging, comparison with previous/standard results, and evaluation techniques.

Multimedia in TTS

A Team Training Shell, like many other shells, should hide the implementation details, providing the author with a convenient tool for creating the target application. The TTS architecture is based on a number of distributed workstations, one for each trainee, connected through a high-speed communication network. Each trainee sees and operates the system from his/her viewpoint. Concurrently, the trainer can show a global view of the whole system to each trainee or to all of them. The trainee is supposed to follow the scenario activated by the trainer and respond as s/he is expected.

A typical screen display comprises several independent views: The trainee view, the integrated general view, general common information view and a dialog-box for menu-driven interaction, through which the trainee performs the simulated actions and communicates with his peers. The trainee's view is extracted from the integrated view and can be manipulated by each trainee for himself. Normally, this view is used for showing the trainee a video clip that represents the simulated reality at that moment. A typical training team includes team members, one of whom is designated as the team head. A regular team member may look at his own view, which displays his role and past performance. The Team Head is the member who is in charge of the team and instructs the other team members. In the case of trauma treatment teams this is the chief physician. In a tank crew this is the tank commander, etc. The Team Head, like the trainer, has the option of looking at an integrated view of the session and the capability of monitoring and following each of the member's view at any time. He may also issue commands for session flow changing or problem solving.

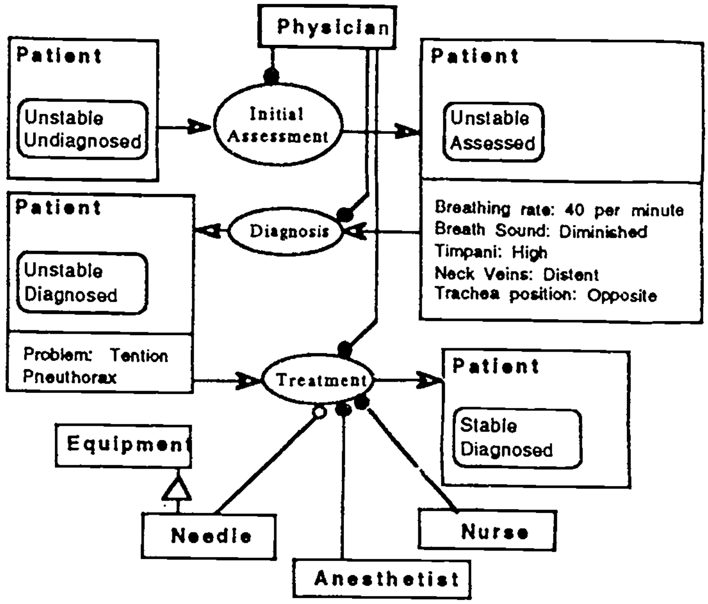

Figure 3: The Treatment process of a trauma patient with Tension Pneuthorax

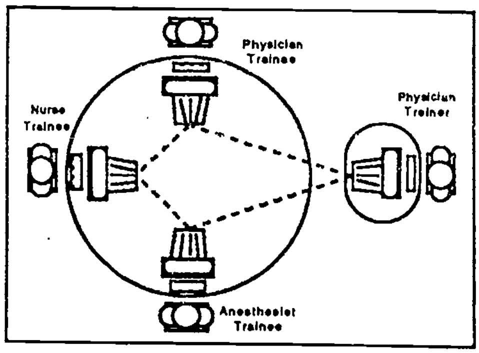

Figure 4: An overview of a team training setup

A Trauma scenario example

The treatment process begins with an initial assessment. This is followed by the definition of the immediate problems causing the stabilization interference. It ends with an application of the appropriate treatment. The initial assessment is divided into the following check sequence: Airway, Breathing, Circulation and Disability (known as "ABCD").

The problem addressed in this example is *tension pneuthorax* . The trainee should diagnose it from the description and data provided in the scenario.

Figure 3 is an "explosion" (procedural scaling-up) of the Treatment process described in figure 1, showing three sub-processes: Initial Assessment, Diagnosis and Treatment.

A trauma patient is evaluated by the three attributes: Assessment (unassessed / assessed), Diagnosis (undiagnosed / diagnosed), and Stability (unstable / stable). Each attribute combination is a different *status* of the patient. The mission of the team can now be formulated as changing the patient status from (unassessed, undiagnosed, unstable) into (assessed, diagnosed, stable).

Figure 4 shows a set-up of a team consisting of a Trainer Physician and three trainees:

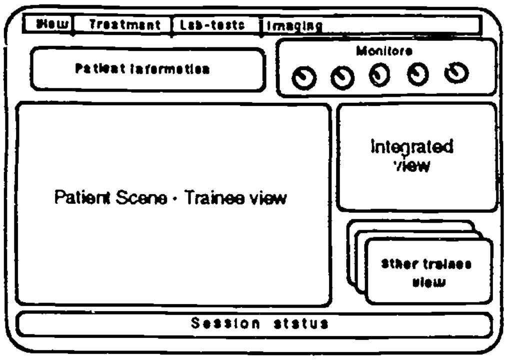

Figure 5: TTS trainee interaction screen

Physician, who is the Team Head, Nurse, and Anesthetist. Each of the four members is equipped with a workstation through which s/he sees the scene, communicates with the other team members, and performs the required activities.

Figure 5 depicts the layout of each trainee interaction screen. The main part of the screen is devoted to the trainee specific view. Another frame displays the team view which the trainer usually sees. A view usually displays a video movie representing the scenario as it proceeds. It constantly changes as the session proceeds, and can be controlled by the trainer. The trainee may ask to perform video operations such as switching the specific view with the team view and zooming part of the view. Another part displays the current monitor results, such as blood pressure, beep rate, breathing rate etc. The status bar is used for session orientation, it shows the current session stage, the time left and performance evaluation. In addition to the permanent display portions, the trainee may use a menu to see other trainees view, select and activate applicable operations, and display lab results and electronic images.

The training session begins with a video movie presenting a patient breathing spontaneously, but with a very high rate. The scenario is set so as to allow the physician to detect the patient's parameters by displaying the patient in various positions and angles and viewing the data displayed by the monitoring equipment. The trainer may slow or even stop the running scene and rewind the scenario if deemed necessary. Consultation among team members is enabled either by directly addressing each other or issuing a consultation request through the system.

In our example, the physician is expected to acquire the data concerning the patient's breathing rate. If he does so within the expected time frame, the system responds with the (exceptional high) value of 40 beats/minute. Otherwise, the patient's condition continues to deteriorate as the session proceeds. Using the knowledge of very high breathing rate, the physician is now expected to watch and, using audio capabilities, listen carefully to detect findings in breath sound, percussion, significant distention of neck veins and changes in the position of the trachea. Following this assessment process the physician is expected to obtain the following results: the patient has a diminished breath sound in the left side, left hyper-timpani, distention of neck veins, and opposite trachea position. The physician should be able to determine the problem. The number of possible attribute value combinations grows combinatorially. It makes the diagnosis process highly complicated. At any decision point the trainee has a number of possibilities from which he has to select and proceed. The score of each action determines whether the system allows the scenario to proceed or else prevents it while issuing an appropriate explanation. Normally there is one recommended option in the scenario tree. Some of the possible actions are completely wrong, as they lead to catastrophic results. The system or the trainer may prevent such actions from being selected by any trainee. Assuming the correct assessment has been selected, the physician determines the problem and

notifies the team of his diagnosis along with the treatment to be performed. Then, the physician asks the nurse to prepare the patient for a needle insertion to the chest. The nurse is supposed to perform a series of preparatory activities: undressing the patient, cleaning the chest, supply equipment, etc. This is done by selecting operations from a list of possible operations displayed through the menu bar, and applying them to the patient's body by pointing to the appropriate body location. Each applied operation that has a visual effect on the presentation is displayed, either by moving to the appropriate video frame or by combining a still picture with the video movie. After the patient is ready for the needle insertion, the physician selects the needle size from a displayed list or, points to the exact location and then inserts the needle. As a result of this treatment, the patient's condition is stabilized within the appropriate time span.

Conclusion

We have introduced the concept of Team Training Shell (TTS) and its components. Multimedia technology and coordination management are two key components of TTS. There are many theoretical and technological details in the supporting environment that may not yet be ripe for the required application we have described. A major obstacle is the lack of tools that support concurrent distributed multimedia display and control. To prove that the implementation of a team training executable is at all a feasible task, we expect, as a first stage, to accomplish the analysis, design, and implementation of a prototype that demonstrates the concept.

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